

BEYOND EINSTEIN: From the Big Bang to Black Holes



# Constellation

*The Constellation X-Ray Mission*

## ►► Project Scientist Perspective

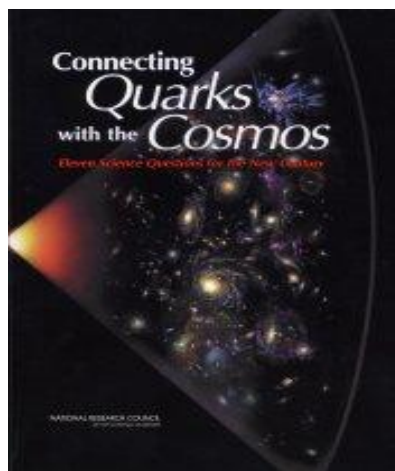
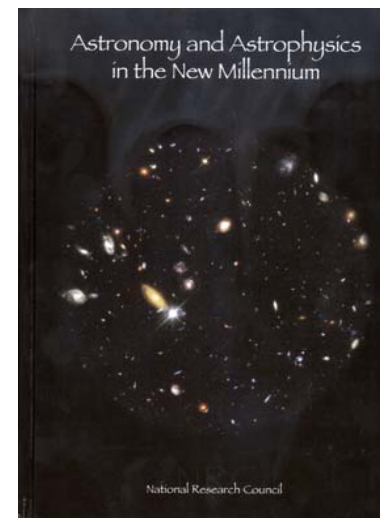
Presented by  
**Nicholas White (GSFC)**

*Facility Science Team Meeting  
February, 15-16, 2006*



# Science Priority

The Astronomy and Astrophysics in the New Millennium “decadal survey” ranked Constellation-X next priority to the JWST for large new space observatories



The National Academy Committee chaired by Michael Turner prepared a science assessment and strategy for research at the intersection of Physics and Astronomy strongly endorsed the Constellation-X mission

# Project Scientist Mission Update

- Science case recently updated and reaffirmed
- Single Delta IVH instead of two Atlas IV launchers under study that may reduce mission cost while maintain science capability
- Loss of Suzaku X-Ray Spectrometer (XRS) leaves major gap and the promise of micro-calorimeter technology unrealized until Constellation-X
- Constellation-X is an extension of heritage technologies and development continues to progress well, with excellent leverage off the R&A program
  1. Technology solicitation
  2. Mission Status and the FY2007 budget

# Quotes from Presidents 2007 Budget

The Beyond Einstein program budget reflects an indefinite deferral of the *start of development* of the LISA and Constellation-X mission activities. Technology and science studies will continue with the goal of selecting a mission for development later this decade (including Joint Dark Energy Mission).

The focus in 2007 will be on the results of a priority and technology readiness review of the three missions in the Beyond Einstein Program. NASA will proceed with advanced studies on the Joint Dark Energy Mission and minimal technology advancement on LISA and Con-X.

The selection and timing of mission(s) for formulation will depend on the outcome of this review.

Beyond Einstein Budget Guidelines (including Con-X and LISA) are:

FY06	FY07	FY08	FY09	FY10	FY11
\$14M	\$21M	\$21M	\$53M	\$152M	\$175M

***Discussions ongoing with HQ on the minimum budget required in FY06 and FY07 to sustain the Constellation-X project***

# Overall Mission Status

## Constellation-X is Pre-phase A

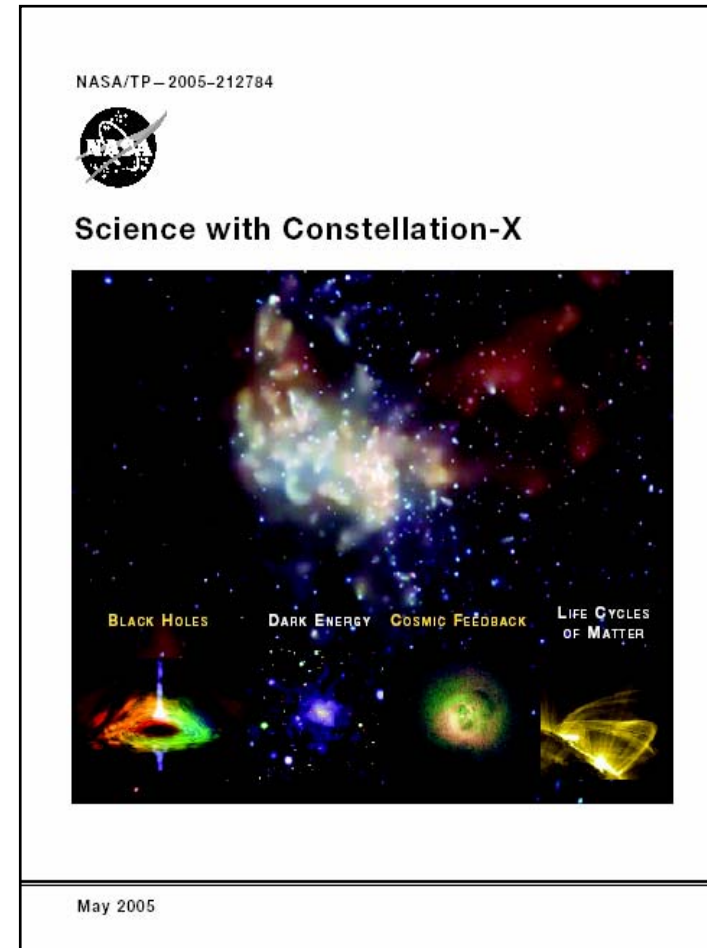
- Primarily technology development in TRL3-6 range, combined with mission architecture studies, science requirements documentation, and flow down to mission implementation
  - Be careful what you ask for! Requirements must equate to technical reality, mission cost and schedule
- End to end cost estimate for 2017/18 launch date:
  - \$2.5B (Real Year dollars including inflation), or
  - \$1.6B (Constant Year 2000 dollars)
- Launch date is currently driven by budget constraints, not technology or schedule
  - Will be reassessed based on FY2007 budget
  - Goal is to keep the mission well placed to fill the wedge that opens up starting FY09, by HST SM4 servicing and JWST passing its peak



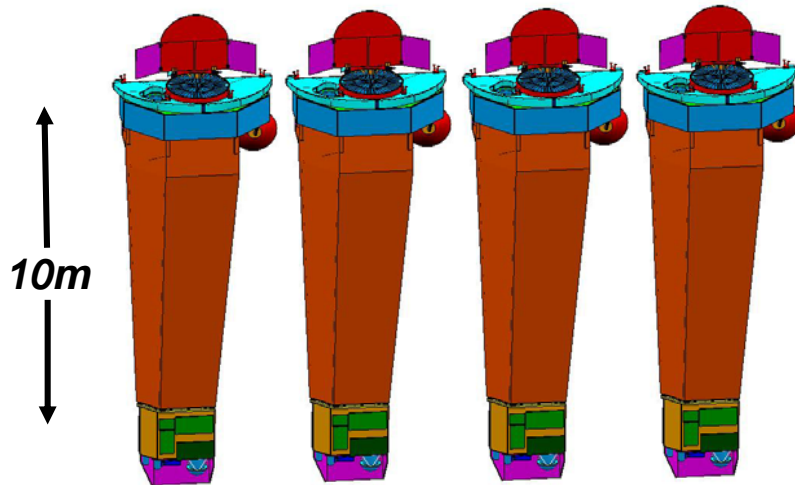
# The Constellation-X Science Case Update

- October 2004 through January 2005, >60 scientists met in small groups and produced 13 white papers (100 pages of text)
- Goal: Update the Constellation-X science case given progress by Chandra and XMM-Newton over past 5 years
  - Team leaders in this effort:
    - David Alexander (IoA)
    - Jean Cottam (GSFC)
    - Jeremy Drake (CfA)
    - Jack Hughes (Rutgers)
    - Casey Lisse (U Md)
    - Jon Miller (U Mich)
    - Michael Muno (UCLA)
    - Richard Mushotzky (GSFC)
    - Frits Paerels (Columbia)
    - Chris Reynolds (U Md)
    - Gordon Richards (JHU)
    - Michael Shull (Colorado)
    - Randall Smith (JHU/GSFC)
    - David Strickland (JHU)
    - Tod Strohmayer (GSFC)

**Result of the Process:**  
**“Science with Constellation-X” booklet**

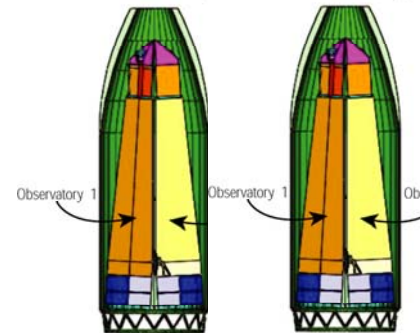


# Mission Configuration Trade Study



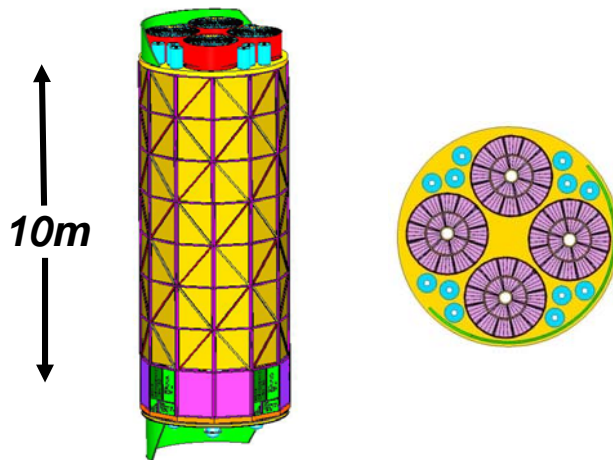
## Reference Design

*Launched in pairs on 2 Atlas V class launchers*



## Alternate Design

*Single launch on the new Delta IVH launcher*

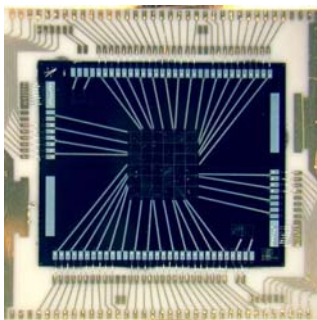


**Launch cost saving of ~\$120M with no loss in science capability**

# X-ray Micro-calorimeters

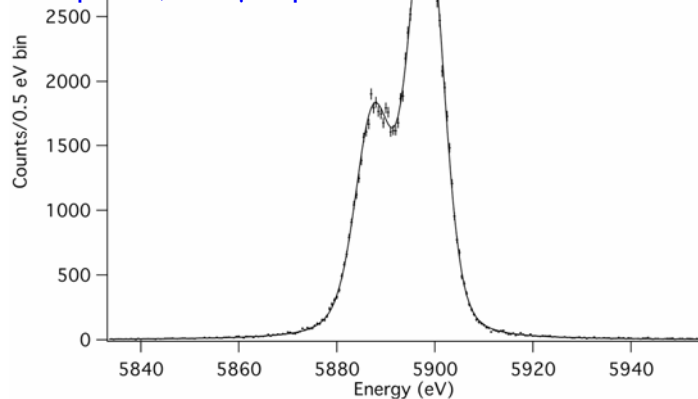
Thermal detection of individual X-ray photons gives a 20-40 increased spectral resolution over the Chandra CCDs

Arrays have been successfully demonstrated on sounding rockets and now *Suzaku* (Astro-E2)

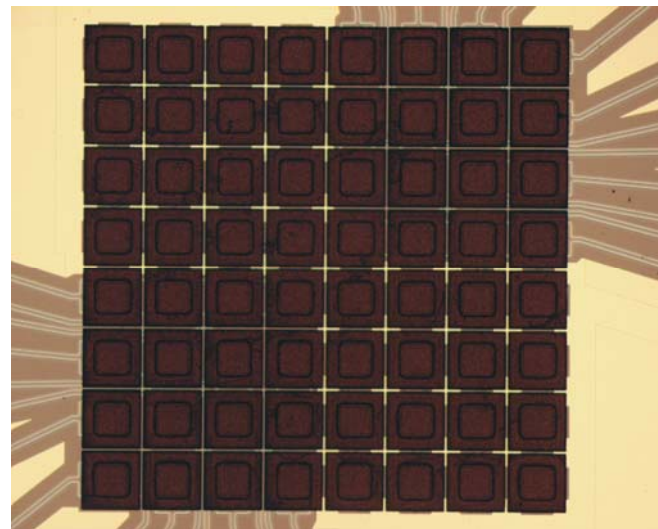


*Suzaku* X-ray calorimeter array achieved 7 eV resolution on orbit

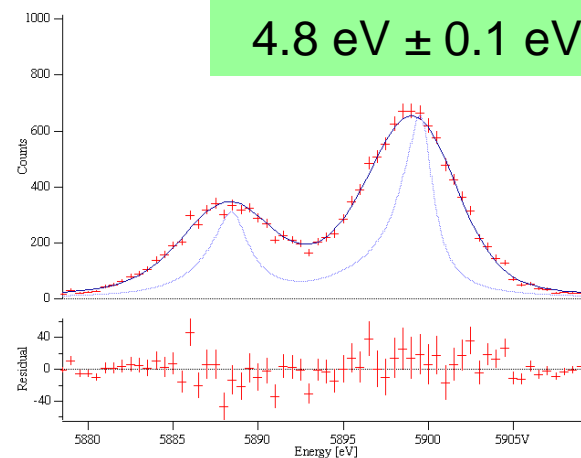
XRS: 32 pixels, 640  $\mu\text{m}$  pixels



Next generation arrays being developed for Constellation-X now approaching mission goals of 2-4 eV



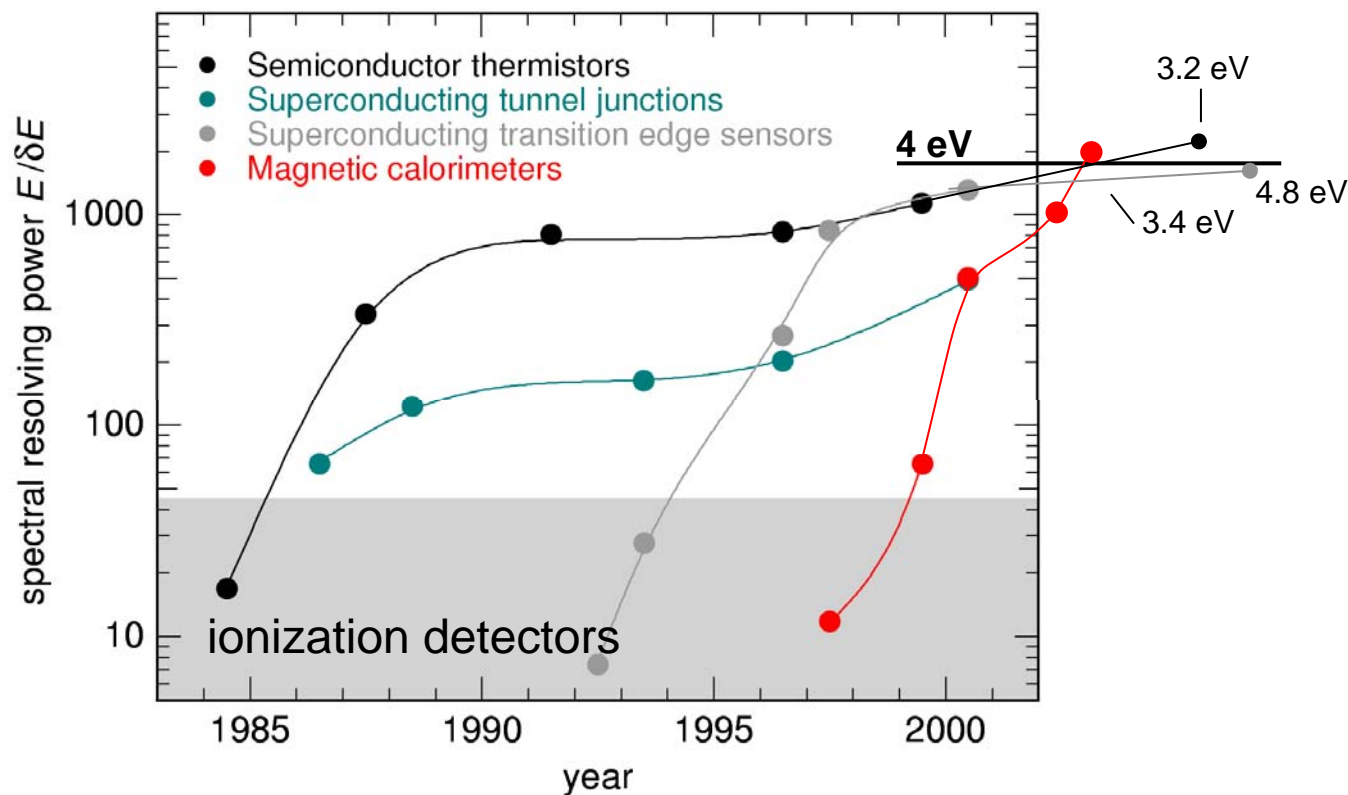
8x8 development TES array for Con-X with 250  $\mu\text{m}$  pixels



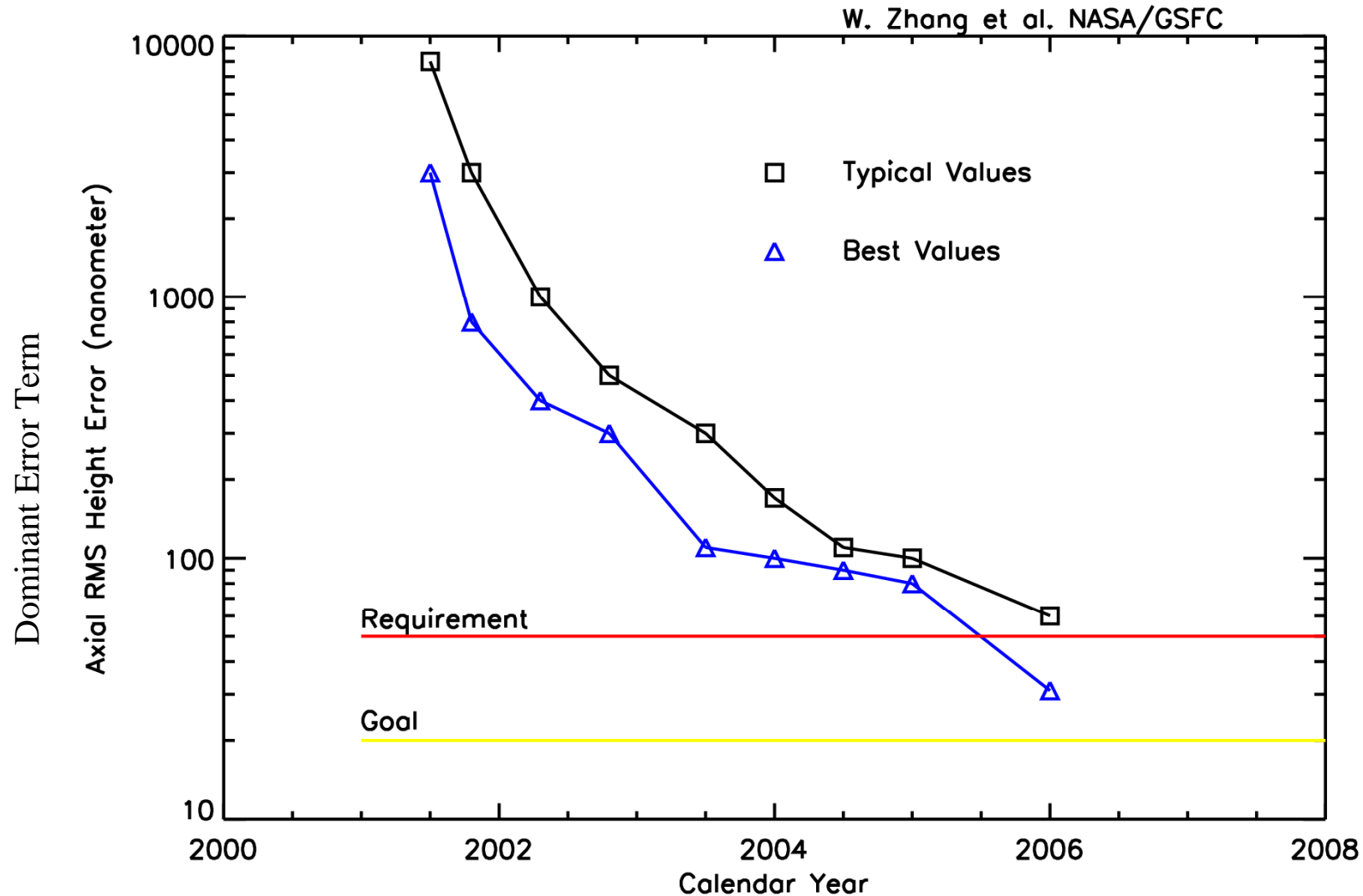
4.8 eV  $\pm$  0.1 eV FWHM



# Micro-calorimeter Progress: $\Delta E @ 6 \text{ keV}$



# Spectroscopy X-ray Telescope Reflector Progress



# Technology Solicitation

- Solicitation for Con-X instrument incubator technology development currently being planned:
  - Continuation of technology development
  - Amendment to ROSES NRA
  - Focus on Constellation-X instrument development for microcalorimeters, gratings/CCDs, hard X-ray detectors/optics
  - Multi-year substantial grants for technologies currently at technology readiness level 3 to 5, to advance a TRL
  - Enable teams to compete for future instrument Announcement of Opportunity

**Decision as to whether and when to proceed pending discussion of FY2007 budget with HQ**

# Summary

- The Beyond Einstein mission Constellation-X addresses compelling and high priority science questions, by opening the window of high throughput, high resolution X-ray spectroscopy
- The technology development continues to make substantial progress, and we still hope to have an instrument incubator NRA when funds allow
- We are currently replanning around the Presidents FY2007 budget with the goal to maintain momentum towards being the next major observatory to follow after JWST

Visit the Constellation-X Website

<http://constellation.gsfc.nasa.gov>